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A Multilayered Interference Film

[What is claimed is:]

(1) A multilayered interference film, being characterized in that a λ/4-film with a large refractive index and a λ/4-film with a small refractive index are layered alternately on a surface of a substrate, and that a transparent photocatalytic layer is layered on the top layer thereof.

(2) The multilayered interference film according to claim 1, wherein said photocatalytic layer is made of at least one material selected from a group including TiO_2, Fe_2O_3, In_2O_3, and WO_3, and has a film thickness of from 0.5 to 5 μm.

(3) The multilayered interference film according to claim 1 or 2, wherein said photocatalytic layer carries at least one metal selected from a group including Pt, Pd, Rh and Ir.

(4) The multilayered interference film according to any one of claims 1 to 3, wherein the multilayered interference film is used for a cold mirror which transmits heat rays and reflects light rays having other wavelengths.

(5) The multilayered interference film according to any one of claims 1 to 3, wherein the multilayered interference film is used for a filter which cuts off transmission of light rays having wavelengths other than a selected wavelength.

[Detailed Description of the Invention]

[Technical Field]

The present invention relates to a multilayered interference film for selectively transmitting or reflecting light having a specific wavelength.

[Background Art]

Conventionally, in a lighting instrument using an HID light source such as a mercury lamp and/or in an ultraviolet lamp having a high output for an ultraviolet-ray curing apparatus, there are drawbacks that an object to be irradiated is damaged by irradiation of unnecessary heat rays or ultraviolet rays emitted from a lamp, and/or that a user feels uncomfortable with this heat.

For example, with an ultraviolet lamp for an ultraviolet-ray curing apparatus, as shown in FIG. 6, a reflector plate 4 of an aluminum plate is disposed behind an ultraviolet lamp 5 to improve the efficiency of ultraviolet radiation. However, there is a good likelihood that an object to be irradiated is damaged since heat rays are also

irradiated upon the object at the same time.

For the purpose of preventing damage of an object to be irradiated and/or discomfort of the user due to heat, removal of unnecessary heat rays and/or ultraviolet rays is conducted by means of a multilayered interference film 1' as shown in FIG. 8. This multilayered interference film 1' is obtained by forming a $\lambda/4$-film H of a material having a large refractive index and having a thickness approximately equal to the light wavelength, and a $\lambda/4$-film L of a material having a small refractive index and having a thickness approximately equal to the light wavelength alternately, whereby it selectively transmits or reflects only light having a specific wavelength by using interference of the light within each $\lambda/4$-film.

When such a multilayered interference film 1' is used in the ultraviolet-ray curing apparatus mentioned above, it can be used as the reflector plate 4 instead of the aluminum plate as shown in FIG. 7 (a). In this case, this multilayered interference film 1' transmits heat rays and visible light rays, however reflects ultraviolet rays, as can be seen from FIG. 9. Thus, it is used as a cold mirror. In such a cold mirror, ultraviolet rays are reflected upon the multilayered interference film 1' so as to reach an object to be irradiated, however heat rays and visible light rays are transmitted through the multilayered interference film 1' so as not to reach the object to be irradiated. Accordingly, there is no fear that the object to be irradiated will be thermally damaged.

The multilayered interference film 1' can also be used as a filter 6, which is disposed in the front of the ultraviolet lamp 5 for the ultraviolet-ray curing apparatus, as shown in FIG. 7 (b). In this case, the multilayered interference film 1' reflects heat rays and visible light rays, however transmits ultraviolet rays, as can be seen from FIG. 10. When the filter 6 is disposed in the front of the ultraviolet lamp 5, among light generated directly from the ultraviolet lamp 5 and collected by the reflector plate 4, components of heat rays and visible light rays thereof are reflected upon this filter 6, and thereby only ultraviolet rays reach an object to be irradiated. Accordingly, there is also no fear that the object to be irradiated will be thermally damaged.

Also, when this multilayered interference film 1' is used for purposes other than use in the ultraviolet-ray curing apparatus mentioned above, the multilayered interference film 1' is arranged to remove light having a wavelength to be removed.

For example, for the purpose of preventing discomfort caused by the heat in an HID lamp such as a mercury lamp, this multilayered interference film 1' may be manufactured as a filter which reflects only heat rays and transmits light having other wavelengths, or as a cold mirror which transmits only heat rays and reflects light having other wavelengths. Also, for the purpose of protecting an object to be

irradiated from damage due to ultraviolet rays, this multilayered interference film 1' may be manufactured as a filter which reflects only ultraviolet rays, or as a reflection mirror which transmits only ultraviolet rays.

As mentioned above, by using the multilayered interference film 1', it is possible to remove unnecessary heat rays, ultraviolet rays or the like, however such a multilayered interference film 1' has a drawback that suspended materials (mainly, organic materials) in the ambient atmosphere adhere to the surface thereof during use over a long time period, and thereby efficiency in reflectance or in transmittance is deteriorated. For example, when it is used in the ultraviolet-ray curing apparatus for one (1) year, the efficiency can be deteriorated by 20-50%, depending upon the atmosphere at the site of use. For this reason, when such a multilayered interference film 1' is used, it is necessary to clean the surface thereof. However, since organic materials and other contaminants become adhered to the surface of theλ/4-film, these deposits cannot be removed so easily.

[Purpose of the Invention]

The present invention takes the drawback mentioned above into consideration and aims at providing a multilayered interference film which can maintain an original high efficiency in reflectance or transmittance thereof for a long period of time.

[Disclosure of the Invention]

For achieving the purpose mentioned above, according to the present invention, there is provided a multilayered interference film, being characterized in that a λ/4-film with a large refractive index and a λ/4-film with a small refractive index are layered alternately on the surface of a substrate, and that a transparent photocatalytic layer is layered on the top layer thereof.

Hereinafter, a detailed explanation will be given on the present invention with reference to the drawings.

As shown in FIG. 1, the multilayered interference film 1 according to the present invention is comprised of a λ/4-film H with a large refractive index and a λ/4-film L with a small refractive index, which are alternately layered on a substrate 2, and in this aspect, it does not differ from the conventional art.

As a material for the λ/4-film H or the λ/4-film L, the same chemical compound as the conventional one can be used. For example, for the λ/4-film H with a large refractive index, a thin film of a high refractive material having a refractive index of around 2.0-2.6 such as TiO_2, CeO_2, ZrO_2, or ZnS can be used. For the λ/4-film L with a small refractive index, a thin film of a low refractive material having a refractive index of around 1.3-1.6 such as CaF_2, MgF_2, SiO_2, or Al_2O_3 can be used. By

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selecting the combination of those chemical compounds mentioned above and the film thickness of the λ/4-film H and the λ/4-film L appropriately, it is possible to reflect or transmit light having selected wavelengths.

As a method for forming the λ/4-film H and the λ/4-film L, the same method as the conventional one can be used. For example, it is possible to employ a vacuum evaporation method using resistance heating, an electron beam evaporation method using an electron gun, a sputtering method, an ion plating method, or the like. Also, when the λ/4-film H and the λ/4-film L is formed by the method mentioned above, the substrate may be heated to be equal to or greater than the room temperature. In general, the higher the temperature of the substrate, the higher the hardness of the formed thin film, whereby the durability thereof can be improved. However, if the substrate temperature is too high, there is a good likelihood that the workability or productivity thereof will be deteriorated. Therefore, the substrate temperature is preferable in the range of from the room temperature up to about 350 °C.

According to the present invention, a transparent photocatalytic layer 3 is formed on the top layer of plural sets of the λ/4-film H and the λ/4-film L which are formed in the manner mentioned above.

As the chemical compound to be used for the photocatalytic layer 3, at least one compound selected from a group including TiO_2, Fe_2O_3, In_2O_3, and WO_3 can preferably be used.

The photocatalytic layer 3 made of such a material can be formed in the same manner as for the λ/4-films mentioned above. That is, it is possible to employ a vacuum evaporation method using resistance heating, an electron beam evaporation method using an electron gun, a sputtering method, an ion plating method, or the like. Further, the photocatalytic layer 3 may be formed by applying a solution of organic metal compounds including the metal (Ti, Fe, In, W, etc.), which is contained within the chemical compound mentioned above, to the surface of the multilayered λ/4-films, drying, and baking at a high temperature.

The film thickness of the photocatalytic layer 3 formed by this method is, although it should not be limited thereto, preferably about 0.5-5 μm. If the film thickness of the photocatalytic layer 3 is less than 0.5 μm, the photocatalytic effect thereof is not sufficient, and also, since it comes close to the film thickness of the λ/4-film, there is a good likelihood that an interference may occur between the photocatalytic layer 3 and the λ/4-film, which causes a change of the wavelength of light which can selectively be reflected or transmitted. If the film thickness of the photocatalytic layer 3 exceeds 5 μm, there is a good likelihood that the transparency

thereof may be deteriorated, and even if the transparency may not be deteriorated, the photocatalytic effect thereof is not so different from the case of the film thickness being less than 5 μm.

For the photocatalytic layer 3 mentioned above, it is also possible to carry or contain further at least one metal selected from a group including Pt, Pd, Rh and Ir. Such metal functions as catalysts to decompose any attached dirt. By allowing the photocatalytic layer 3 to carry such metals, it is possible to improve the function of removing dirt or contaminants.

As a method for allowing the photocatalytic layer 3 to carry such metals, although it should not be limited thereto, a method comprising the following steps can be applied:

preparing an aqueous solution of soluble salt of the above-mentioned metal;

immersing the multi-layered interference film 1 on which the above-mentioned photocatalytic layer 3 is formed into the solution and thereby allowing the soluble salt to soak into the photocatalytic layer 3;

thereafter irradiating ultraviolet rays or the like thereupon, decomposing the soluble salt, and thereby allowing the photocatalytic layer 3 to carry the above-mentioned metal.

Further, with respect to the amount of the metal carried on the photocatalytic layer 3, although it should not be limited to a particular amount, it is preferable to carry 0.1 - 2% of the metal with respect to the photocatalytic layer 3. If the amount is less than 0.1%, the effect is not sufficient. If it exceeds 2%, there is a good likelihood that the transparency of the photocatalytic layer may be deteriorated.

As was mentioned in the above, the multilayered interference film, according to the present invention, in which the λ/4-film H of a large refractive index and the λ/4-film L of a small refractive index are layered alternately on a surface of the substrate 2, and the transparent photocatalytic layer 3 is formed on the top layer thereof, can be used as the reflector plate 4 of the ultraviolet-ray curing apparatus as shown, for example, in FIG. 4. In this instance, the multilayered interference film 1, as shown in FIG. 2, must be the so-called cold mirror which transmits heat rays and reflects light having other wavelengths. With such a cold mirror, light rays other than the heat rays emitted from the ultraviolet lamp 5 are reflected upon the multilayered interference film 1 so as reach an object to be irradiated, however the heat rays pass through the multilayered interference film 1 so as not to reach the object to be irradiated. Accordingly, there is no likelihood that the object to be irradiated will be thermally damaged.

Also, the multilayered interference film 1, according to the present invention, may be disposed at the front of the ultraviolet lamp 5 of the ultraviolet-ray curing apparatus so as to be used as a filter 6, as shown in FIG. 5. In this instance, this multilayered interference film 1 must be one which reflects heat rays and visible light rays and transmits ultraviolet rays, as shown in FIG. 3. When such a filter 6 is disposed at the front of the ultraviolet lamp 5, among light generated directly from the ultraviolet lamp 5 and that collected by the reflector plate 4, components of heat rays and visible light rays are reflected upon this filter 6, and thereby only ultraviolet rays reach an object to be irradiated. Accordingly, there is also no likelihood that the irradiated object will be thermally damaged.

As mentioned above, with respect to the multilayered interference film 1 according to the present invention, which is used as a reflector plate or a filter, if suspended materials (mainly, organic materials) in the ambient atmosphere adhere to the surface of the photocatalytic layer 3 formed on the top layer thereof, the materials are decomposed and removed by functions of the metal compounds such as TiO_2, Fe_2O_3, In_2O_3, or WO_3 in the photocatalytic layer 3, and further by the metals such as Pt, Pd, Rh or Ir, acting with ultraviolet rays from the light source. Therefore, since such dirt does not remain on the surface of the photocatalytic layer 3, it is possible to reliably keep the surface clean.

The multilayered interference film 1 according to the present invention can be applied to purposes other than the ultraviolet-ray curing apparatus mentioned above, in the same manner as in the conventional art.

For example, for the purpose of preventing discomfort of the user due to heat in the HID lamp such as a mercury lamp, it is sufficient to manufacture the multilayered interference film 1 according to the present invention as a filter for reflecting only heat rays and transmitting light having other wavelengths, or as a cold mirror for transmitting heat rays and reflecting other light. Also, for preventing an object to be irradiated from being damaged by ultraviolet rays, it is sufficient to manufacture the multilayered interference film 1 according to the present invention as a filter for reflecting only ultraviolet rays, or as a reflector for transmitting only ultraviolet rays. In summary, if a $\lambda/4$-film of a large refractive index and a $\lambda/4$-film of a small refractive index are layered alternately on the surface of a substrate and a transparent photocatalytic layer is formed on the top layer thereof, other structures should not be limited to a particular one.

Next, explanations will be given on embodiments of the present invention together with comparative examples.

(Embodiment 1)

While a hard glass substrate made by press forming is heated at a temperature of 300 °C in a vacuum of 1×10^{-4} - 2×10^{-6} Torr, a λ/4-film of a large refractive index comprised of titanium oxide (TiO_2) and a λ/4-film of a small refractive index comprised of magnesium fluoride (MgF_2) are formed alternately on the substrate by an electron beam evaporation method, and thereby 15 layers of the λ/4-film are laminated. Next, on the top layer of the 15 layers, titanium oxide (TiO_2) is evaporated by the same electron beam evaporation method so as to form a photocatalytic layer having a thickness of 1.0 – 1.2 μm, and thereby a cold mirror on the surface of which a multilayered interference film is formed is obtained. The obtained cold mirror has a mean reflectance of visible light rays (450 – 750 nm) of 93%, and a mean transmittance of heat rays (800 – 2,400 nm) of 82%. When such a cold mirror is used as a reflector plate of a mini halogen lamp spotlight, even after 10,000 hours of operation, almost no dirt adheres to the surface thereof, and there is almost no change in the mean reflectance and the mean transmittance.

(Embodiment 2)

The λ/4-film of 15 layers obtained in embodiment 1 is repetitively immersed in a 5% ethanol solution of tetraisopropoxy titanium ($Ti(O\text{-}iC_3H_7)_4$), dried, and thereafter baked at a temperature of 500 °C for 30 minutes, and thereby a multilayered interference film having a photocatalytic layer of titanium oxide formed thereon is obtained. The film thickness of the obtained photocatalytic layer is 1 μm. Next, the hard glass substrate with the multilayered interference film is immersed in an aqueous solution of platinum chloride, ultraviolet light is irradiated thereupon so as to allow the photocatalytic layer to carry platinum therein, and thereby a cold mirror is obtained. The amount of platinum carried in the photocatalytic layer is 1%. The cold mirror obtained in this manner has a mean reflectance of visible light rays of 92%, and a mean transmittance of heat rays of 80%. When such a cold mirror is used as a reflector plate of a mini halogen lamp spotlight, even after 10,000 hours operation, almost no dirt adheres to the surface thereof, and there is almost no change in the mean reflectance and the mean transmittance, in the same manner as embodiment 1.

(Comparative example 1)

A cold mirror is manufactured in the same manner as embodiments 1 and 2, except that no photocatalytic layer is formed upon the top layer of the λ/4-film of 15 layers. The mean reflectance of visible light rays of the obtained cold mirror is 93% and the mean transmittance of heat rays is 82% just after the mirror is manufactured. When such a cold mirror is used as a reflector plate of a mini halogen lamp spotlight,

after 10,000 hours operation, considerable dirt adheres to the surface thereof, whereby the mean reflectance of visible light rays is deteriorated to 80% and the mean transmittance of heat rays is deteriorated to 67%.

(Embodiment 3)

While a hard glass substrate formed into a parabola shape by heat-bend forming is heated at a temperature of 300 °C in a vacuum of $1\times10^{-4}-2\times10^{-6}$ Torr, a λ/4-film of a large refractive index comprised of titanium oxide (TiO_2) and a λ/4-film of a small refractive index comprised of silicon oxide (SiO_2) are formed alternately on the substrate by an electron beam evaporation method, and thereby 15 layers of the λ/4-film are laminated. Next, upon the top layer of the 15 layers, indium oxide (In_2O_3) is evaporated by the same electron beam evaporation method so as to laminate thereon a photocatalytic layer having a thickness of 1.0 – 1.2 μm, and thereby a cold mirror on the surface of which a multilayered interference film is formed is obtained, as shown in FIG. 4. The obtained cold mirror has a mean reflectance of ultraviolet rays (250 – 400 nm) of 87% and a mean transmittance of visible light rays and heat rays (450 – 2,400 nm) of 95%. When such a cold mirror is used as a reflector plate of an ultraviolet curing apparatus, even after 3,000 hours operation, almost no dirt adheres to the surface thereof, and there is almost no change in the mean reflectance and the mean transmittance.

(Embodiment 4)

The λ/4-film of 15 layers obtained in embodiment 3 is repetitively immersed in a 5% ethanol solution of tetraisopropoxy titanium ($Ti(O\text{-}iC_3H_7)_4$), is dried, and thereafter is baked at a temperature of 500 °C for 30 minutes, and thereby a multilayered interference film having a photocatalytic layer of titanium oxide formed thereon is obtained. The film thickness of the obtained photocatalytic layer is 1.2 μm. Next, the hard glass substrate with the multilayered interference film is immersed in an aqueous solution of palladium chloride, ultraviolet rays is irradiated thereupon so as to allow the photocatalytic layer to carry palladium therein, and thereby a cold mirror is obtained. The amount of palladium carried in the photocatalytic layer is 0.5%. The cold mirror obtained in this manner has a mean reflectance of ultraviolet rays of 83%, and a mean transmittance of visible light rays and heat rays of 90%. When such a cold mirror is used as a reflector plate of an ultraviolet curing apparatus, even after 3,000 hours operation, almost no dirt adheres to the surface thereof, and there is almost no change in the mean reflectance and the mean transmittance, in the same manner as embodiment 3.

(Comparative example 2)

A cold mirror is manufactured in the same manner as embodiments 3 and 4,

except that no photocatalytic layer is formed upon the top layer of the λ/4-film of 15 layers. The mean reflectance of ultraviolet rays of the obtained cold mirror is 88% and the mean transmittance of visible light rays and heat rays is 97% just after manufactured. When such a cold mirror is used as a reflector plate of an ultraviolet curing apparatus, after 3,000 hours operation, considerable dirt adheres to the surface thereof, the mean reflectance of ultraviolet rays is deteriorated to 75% and the mean transmittance of visible light rays and heat rays is deteriorated to 70%.

(Embodiment 5)

While a hard glass substrate is heated at a temperature of 300 °C in a vacuum of $1\times10^{-4} - 2\times10^{-6}$ Torr, a λ/4-film of a large refractive index comprised of titanium oxide (TiO_2) and a λ/4-film of a small refractive index comprised of magnesium fluoride (MgF_2) are formed alternately on the substrate by an electron beam evaporation method, and thereby 15 layers of the λ/4-film are laminated. Next, upon the top layer of the 15 layers, titanium oxide (TiO_2) is evaporated by the same electron beam evaporation method so as to laminate thereon a photocatalytic layer having a thickness of 1.0 – 1.2 μm, and thereby a filter for removing ultraviolet rays on the surface of which a multilayered interference film is formed is obtained. The obtained filter has a mean reflectance of ultraviolet rays (250 – 400 nm) of 93% and a mean transmittance of visible light rays (400 – 800 nm) of 82%. When such a filter is used as a mini halogen lamp spotlight, even after 10,000 hours operation, almost no dirt adheres to the surface thereof, and there is almost no change in the mean reflectance and the mean transmittance.

(Embodiment 6)

The λ/4-film of 15 layers obtained in embodiment 5 is repetitively immersed in a 5% ethanol solution of tetraisopropoxy titanium ($Ti(O\text{-}iC_3H_7)_4$), dried, and thereafter baked at a temperature of 500 °C for 30 minutes, and thereby a multilayered interference film having a photocatalytic layer of titanium oxide formed thereon is obtained. The film thickness of the obtained photocatalytic layer is 1 μm. Next, the hard glass substrate with the multilayered interference film is immersed in an aqueous solution of platinum chloride, ultraviolet rays is irradiated thereupon so as to allow the photocatalytic layer to carry platinum therein, and thereby a filter for removing ultraviolet rays is obtained. The amount of platinum carried in the photocatalytic layer is 1%. The obtained filter in this manner has a mean reflectance of ultraviolet rays of 92%, and a mean transmittance of visible light rays of 80%. When such a filter is used for a mini halogen lamp spotlight, even after 10,000 hours operation, almost no dirt adheres to the surface thereof, and there is almost no change in the mean reflectance and

the mean transmittance, in the same manner as embodiment 5.

(Comparative example 3)

A filter for removing ultraviolet rays is manufactured in the same manner as embodiments 5 and 6, except that no photocatalytic layer is formed upon the top layer of the λ/4-film of 15 layers. The mean reflectance of ultraviolet rays of the obtained filter is 93% and the mean transmittance of visible light rays is 82% just after manufactured. When such a filter is used for a mini halogen lamp spotlight, after 10,000 hours operation, considerable dirt adheres to the surface thereof, the mean reflectance of ultraviolet rays is deteriorated to 80% and the mean transmittance of visible light rays is deteriorated to 67%.

(Embodiment 7)

While a hard glass substrate is heated at a temperature of 300 °C in a vacuum of $1\times10^{-4} - 2\times10^{-6}$ Torr, a λ/4-film of a large refractive index comprised of titanium oxide (TiO_2) and a λ/4-film of a small refractive index comprised of silicon oxide (SiO_2) are formed alternately on the substrate by an electron beam evaporation method, and thereby 15 layers of the λ/4-film are laminated. Next, upon the top layer of the 15 layers, indium oxide (In_2O_3) is evaporated by the same electron beam evaporation method so as to laminate thereon a photocatalytic layer having a thickness of 1.0 – 1.2 μm, and thereby a filter for transmitting only ultraviolet rays is obtained. The filter has a mean transmittance of ultraviolet rays (250 – 400 nm) of 87% and a mean reflectance of visible light rays and heat rays (450 – 2,400 nm) of 95%. When such a filter is used in an ultraviolet curing apparatus as shown in FIG. 5, even after 3,000 hours of operation, almost no dirt adheres to the surface thereof, and there is almost no change in the mean reflectance and the mean transmittance.

(Embodiment 8)

The λ/4-film of 15 layers obtained in embodiment 7 is repetitively immersed in a 5% ethanol solution of tetraisopropoxy titanium ($Ti(O\text{-}iC_3H_7)_4$), dried, and thereafter baked at a temperature of 500 °C for 30 minutes, and thereby a multilayered interference film having a photocatalytic layer of titanium oxide formed thereon is obtained. The film thickness of the obtained photocatalytic layer is 1.2 μm. Next, the hard glass substrate with the multilayered interference film is immersed in an aqueous solution of palladium chloride, ultraviolet rays is irradiated thereupon so as to allow the photocatalytic layer to carry palladium therein, and thereby a filter for transmitting only ultraviolet rays is obtained. The amount of palladium carried in the photocatalytic layer is 0.5%. The filter obtained in this manner has a mean transmittance of ultraviolet rays of 83%, and a mean reflectance of visible light rays and

heat rays of 90%. When such a filter is used in an ultraviolet curing apparatus as shown in FIG. 5, even after 3,000 hours operation, almost no dirt adheres to the surface thereof, and there is almost no change in the mean reflectance and the mean transmittance, in the same manner as embodiment 7.

(Comparative example 4)

A filter for transmitting only ultraviolet rays is manufactured in the same manner as embodiments 7 and 8, except that no photocatalytic layer is formed upon the top layer of the $\lambda/4$-film of 15 layers. The mean transmittance of ultraviolet rays of the obtained filter is 88% and the mean reflectance of visible light rays and heat rays is 97% just after manufactured. When such a filter is used in an ultraviolet curing apparatus as shown in FIG. 5, after 3,000 hours operation, considerable dirt adheres to the surface thereof, the mean transmittance of ultraviolet rays is deteriorated to 75% and the mean reflectance of visible light rays and heat rays is deteriorated to 70%.

[Effect of the Invention]

The multilayered interference film according to the present invention, as was mentioned above, since a $\lambda/4$-film with a large refractive index and a $\lambda/4$-film with a small refractive index are layered alternately on the surface of a substrate, and a transparent photocatalytic layer is formed on the top layer thereof, it is possible to maintain the original reflectance and/or transmittance for a long period of time.

[Brief Description of Drawings]

FIG. 1 is a view for explaining the structure of an embodiment of the multilayered interference film according to the present invention; FIG. 2 is a graph for showing an example of the relationship between the light wavelength and the reflectance and the transmittance in a case of using the multilayered interference film according to the present invention as a cold mirror; FIG. 3 is a graph for showing an example of the relationship between the light wavelength and the reflectance and the transmittance in a case of using the multilayered interference film according to the present invention as a filter; FIG. 4 is a view for explaining the structure in the case of using the multilayered interference film according to the present invention as a cold mirror; FIG. 5 is a view for explaining the structure in the case of using the multilayered interference film according to the present invention as a filter; FIG. 6 is a view for explaining the conventional reflector plate; FIGS. 7 (a) and (b) are views for explaining the structure of the conventional multilayered interference films in the case of using same as a cold mirror or a filter; FIG. 8 is a view for explaining the structure of the conventional multilayered interference film; FIG. 9 is a graph for showing an example of the relationship between the light wavelength and the reflectance and the

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transmittance in a case of using the conventional multilayered interference film as a cold mirror; and FIG. 10 is a graph for showing an example of the relationship between the light wavelength and the reflectance and the transmittance in a case of using the conventional multilayered interference film as a filter.

1...multilayered interference film 2...substrate 3...photocatalytic layer H...$\lambda/4$-film of large refractive index L...$\lambda/4$-film of small refractive index

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FIG. 1

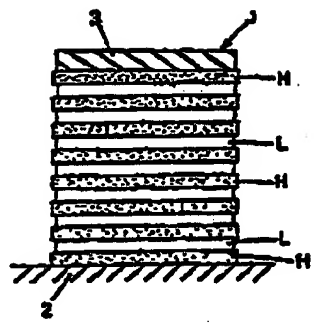

FIG. 2

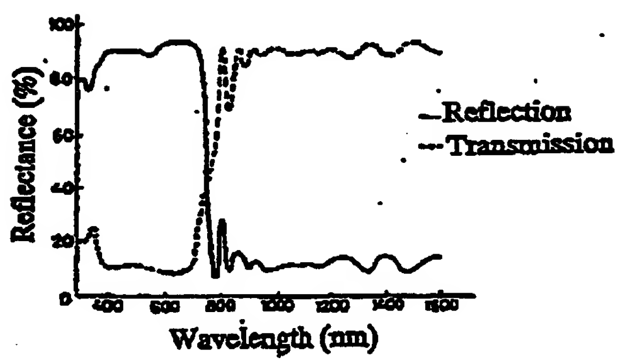

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FIG. 3

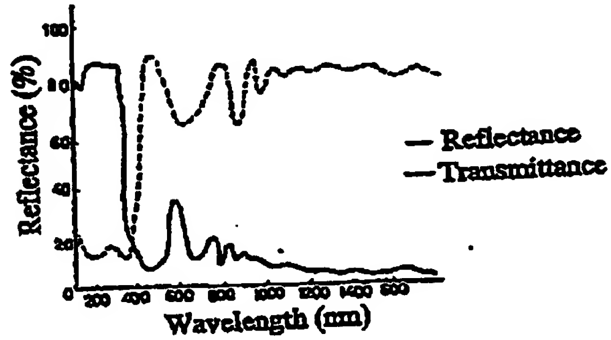

FIG. 6

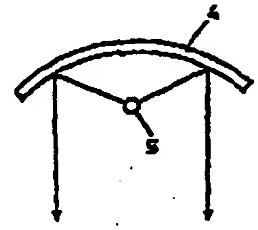

FIG. 4

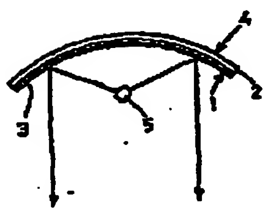

FIG. 5

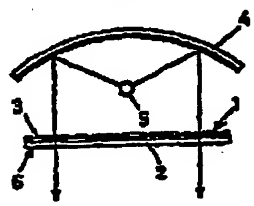

FIG. 7

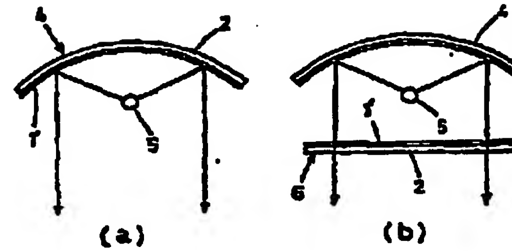

FIG. 8

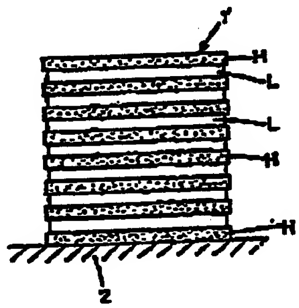

FIG. 9

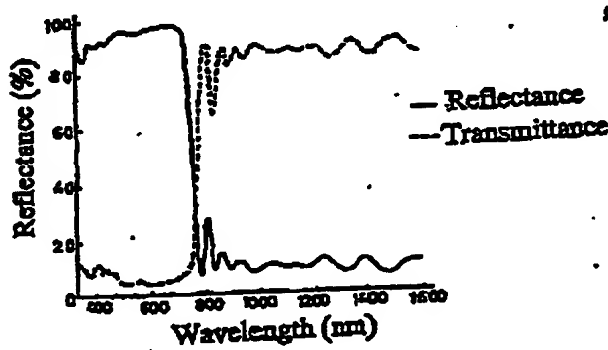

FIG. 10

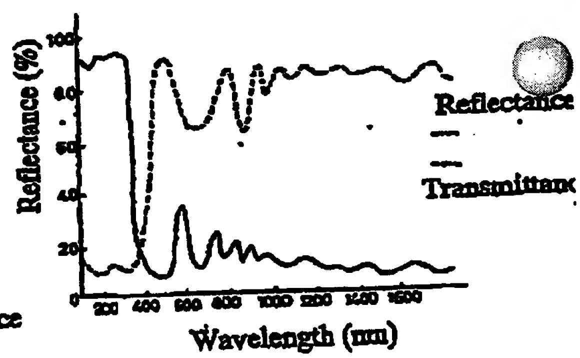

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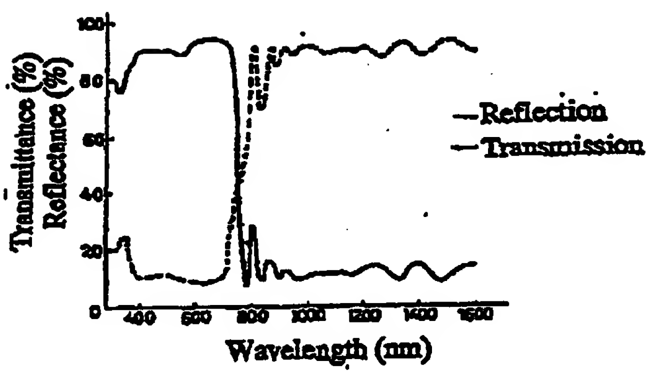
FIG. 2



Received at: 6:21AM, 10/1/2002
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FIG. 3

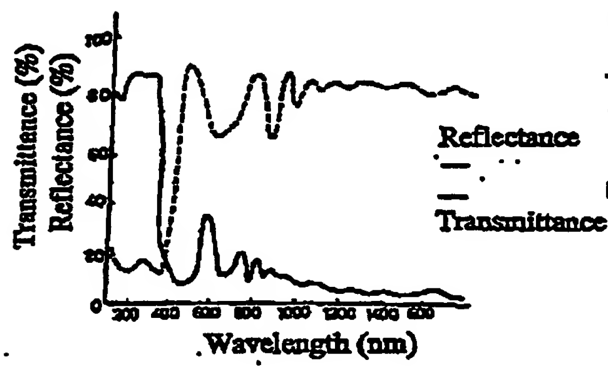


FIG. 9

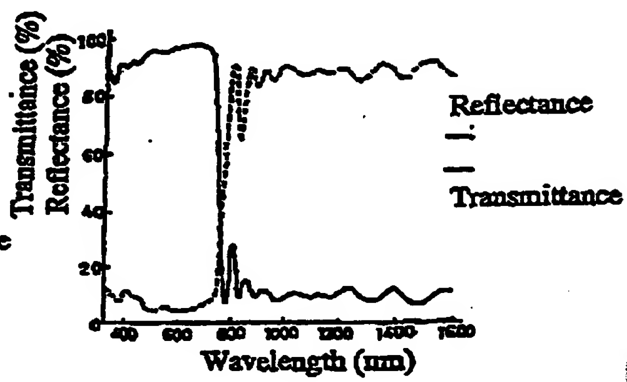
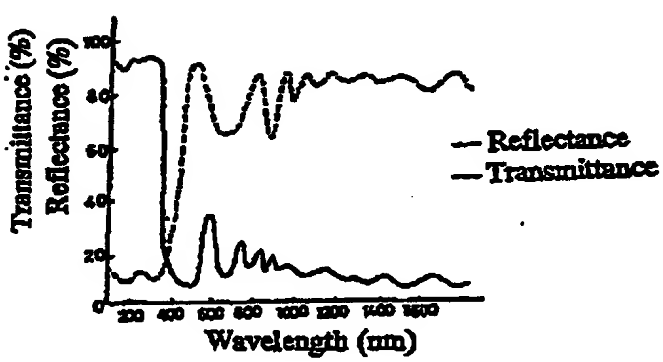


FIG. 10



jp63005304/pn

L3 ANSWER 1 OF 1 WPINDEX (C) 2002 THOMSON DERWENT
ACCESSION NUMBER: 1988-046925 [07] WPINDEX
DOC. NO. NON-CPI: N1988-035346
DOC. NO. CPI: C1988-020965
TITLE: Multilayered interference film - obtd. by alternately stacking film(s) of high and low-refractive index onto base, with photo-catalyst layer contg. titanium oxide etc..
DERWENT CLASS: L02 M13 P81
PATENT ASSIGNEE(S): (MATW) MATSUSHITA ELECTRIC WORKS LTD
COUNTRY COUNT: 1
PATENT INFORMATION:

PATENT NO	KIND	DATE	WEEK	LA	PG	MAIN IPC	
JP 63005304	A	19880111	(198807)*		8		<--

APPLICATION DETAILS:

PATENT NO	KIND	APPLICATION	DATE
JP 63005304	A	JP 1986-149015	19860625

PRIORITY APPLN. INFO: JP 1986-149015 19860625
INT. PATENT CLASSIF.: G02B005-28
BASIC ABSTRACT:

JP 63005304 A UPAB: 19930923
The multilayered interference film is obtd. by alternately stacking the lambda/4 film of high refractive inded and the lambda/ 4 film of small refractive index onto the base surface, and a transparent photocatalyst layer is formed as the uppermost layer. The photocatalyst layer is at least one of TiO_2, Fe_2O_3, In_2O_3 and WO_3, and 0.5-5 micro m film thickness. At least one of Pt, Pd, Rh and Ir is held in the photocatalyst layer. The multilayered interference film is used in the cold mirror which transmits the heat and reflects the light of the other wavelength. The multilayered interference film is used in the filter for cutting the light of the unnecessary wavelength.

USE/ADVANTAGE - The initial reflectivity or the transmittivity can be kept for a long period.

0/10

FILE SEGMENT: CPI GMPI
FIELD AVAILABILITY: AB
MANUAL CODES: CPI: L02-G10; L02-J01; M13-H